October 5, 2010

Mr. Jerald G. Head
Senior Vice President, Regulatory Affairs
GE Hitachi Nuclear Energy
3901 Castle Hayne Road MC A-18
Wilmington, NC 28401

SUBJECT: ECONOMIC SIMPLIFIED BOILING WATER REACTOR AIRCRAFT IMPACT ASSESSMENT INSPECTION, NRC INSPECTION REPORT NO. 05200010/2010-201 AND NOTICE OF VIOLATION

Dear Mr. Head:

On July 26-28, 2010, and August 30 to September 1, 2010, the U.S. Nuclear Regulatory Commission (NRC) conducted an inspection of the General Electric Hitachi Nuclear Energy Corporation (GEH) Aircraft Impact Assessment (AIA) pertaining to activities conducted in support of your application, dated August 24, 2005, for standard design certification and final design approval of the Economic Simplified Boiling Water Reactor (ESBWR) design. This inspection was performed in the offices of GEH located in Wilmington, NC. The purpose of the inspection was to perform a limited-scope inspection to assess GEH's compliance with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.150, "Aircraft impact assessment." The enclosed report presents the results of this inspection. This inspection report does not constitute NRC's endorsement of your overall AIA.

Based on the results of this inspection, the NRC determined that a violation of NRC requirements occurred. The violation is cited in the enclosed Notice of Violation (Notice) and the circumstances surrounding it are described in detail in the subject inspection report. The violation is being cited in the Notice because GEH did not use realistic analyses for certain aspects of its AIA and did not fully identify and incorporate into the design those design features and functional capabilities credited. With the exception of the issues identified in the Notice, the NRC concluded that the portions of the GEH AIA reviewed by the NRC inspection team comply with the applicable requirements of 10 CFR 50.150.

You are required to respond to this letter and should follow the instructions specified in the enclosed Notice when preparing your response. If you have additional information that you believe the NRC should consider, you may provide it in your response to the Notice. The NRC review of your response to the Notice will also determine whether further enforcement action is necessary to ensure compliance with regulatory requirements.

During the inspection, the NRC team encountered significant difficulties due to the lack of documentation associated with the assessment. In several cases the lack of documentation made it difficult for the staff to understand the scope and fundamental assumptions supporting the assessment. The staff is concerned that future COL applicants may not be able to effectively assess plant changes to ensure they do not invalidate the original assessment as required by 10 CFR 50.150(c), Control of changes. The staff has concluded that this task will be difficult with the current level of documentation and as such, your attention in this area is warranted.

It is important to note that the NRC inspection team performed a limited review of the AIA. Many of the deficiencies identified may affect other portions of the AIA that the NRC inspection team did not review. Therefore, GEH must extend its review, where applicable, beyond the specific examples identified by the NRC inspection team and apply corrective actions as appropriate. In its response to this Notice, GEH should document the areas for which it extended its review beyond the specific examples of the deficiencies identified by the NRC inspection team, the extent of its review, the additional findings, and the corrective actions implemented.

In accordance with 10 CFR 2.390 of the NRC's "Public inspections, exemptions, requests for withholding," of the NRC's "Rules of Practice," a copy of this letter, its enclosures, and your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Document Access and Management System (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. To the extent possible, your response, if applicable, should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request that such material is withheld from public disclosure, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If Safeguards Information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21, "Protection of Safeguards Information: Performance Requirements."

Sincerely,

/RA/

Richard Rasmussen, Chief
Quality and Vendor Branch 2
Division of Construction Inspection
& Operational Programs
Office of New Reactors

Docket Nos.: 05200010

Enclosures:
1. Notice of Violation
2. Inspection Report No. 05200010/2010-201 and Attachments

response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Document Access and Management System (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. To the extent possible, your response, if applicable, should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request that such material is withheld from public disclosure, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If Safeguards Information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21, "Protection of Safeguards Information: Performance Requirements."

Sincerely,
/RA/

Richard Rasmussen, Chief
Quality and Vendor Branch 2
Division of Construction Inspection
& Operational Programs
Office of New Reactors

Docket Nos.: 05200010
Enclosures:
1. Notice of Violation
2. Inspection Report No. 05200010/2010-201 and Attachments

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DATE	10/05/2010*	09/23/2010*	10/05/2010*	09/23/2010*	10/05/2010*
OFFICE	NRO/DCIP/CQVA	NRO/DCIP/CQVA/BC	NRO/DE/SEB1/BC	NRO/DRNL/DDIP/NR	QTE
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DATE	09/23/2010*	10/05/2010*	10/05/2010*	10/04/2010*	09/29/2010*
OFFICE	NRO/DNRL/DDLO/NG	AIA FRP Chair	NRO/DCIP/CQVB/BC	OGC/GCHEA/AGCMLE	
NAME	ACubbage	JTappert*	RRasmussen	CScott *	
DATE	10/04/2010*	10/05/2010*	10/05/2010*	10/ 05/2010*	

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NOTICE OF VIOLATION

General Electric Hitachi Nuclear Energy Corporation
Wilmington, NC 28401

Docket Nos.: 05200010
Inspection Report No.: 05200010/2010-201

During a U.S. Nuclear Regulatory Commission (NRC) inspection of General Electric Hitachi Nuclear Energy Corporation (GEH) aircraft impact assessment (AIA) conducted at the GEH, facility in Wilmington, NC, on July 26-28, 2010, and August 30 to September 1, 2010, a violation of NRC requirements was identified. In accordance with the NRC Enforcement Policy, the violation is listed below:

> Title 10, of the *Code of Federal Regulations* (CFR), Section 50.150, "Aircraft impact assessment," Paragraph (a)(1) requires that each applicant listed in 10 CFR 50.150(a)(3) shall perform a design-specific assessment of the effects on the facility of the impact of a large, commercial aircraft. Using realistic analyses, the applicant shall identify and incorporate into the design those design features and functional capabilities to show that, with reduced use of operator actions:
>
> (i) the reactor core remains cooled, or the containment remains intact; and
> (ii) spent fuel cooling or spent fuel pool integrity is maintained.
>
> Contrary to the above, as of September 01, 2010, GEH failed to use realistic analyses in certain aspects of its AIA. Specifically, in its AIA, the applicant failed to accurately determine fire-damage footprints; to adequately consider finite element analyses boundary conditions, initial conditions, and the time duration; to include in the AIA, the basis for not performing mesh refinement sensitivity analyses; to provide a technical justification for the preliminary impact scenarios selected and not selected for the final structural analyses using the NRC specified loading and the material properties given in NEI 07-13, Revision 7; to include in the AIA the bases for not performing an analysis for an aircraft impact on the gantry crane and the corresponding potential effects of the crane dropping on the drywell head; and to consider non-local effects from an aircraft impact. Further, GEH failed to identify and incorporate into the design those design features and functional capabilities credited in the AIA to show the reactor remains cool, or containment remains intact; and spent fuel cooling or spent fuel pool integrity is maintained as required by 10 CFR 50.150(a)(1). Specifically, the AIA credited fire barrier design features that were not identified in the design.
>
> This issue has been identified as Violation 05200010/2010-201-01.
>
> This is a Severity Level IV Violation (Section 6.5).

Pursuant to the provisions of 10 CFR 2.201, "Notice of Violation," GEH is hereby required to submit a written statement or explanation to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001, with a copy to the Chief, Quality and Vendor Branch 1, Division of Construction Inspection and Operational Programs, Office of New Reactors, within 30 days of the date of the letter transmitting this Notice of Violation. This reply should be clearly marked as a "Reply to a Notice of Violation" and should include for each violation (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further violations, and (4) the date when full compliance will be achieved. Your response may reference or include previous docketed correspondence, if the

correspondence adequately addresses the required response. Where good cause is shown, the NRC will consider extending the response time.

If you contest this enforcement action, you should also provide a copy of your response, with the basis for your denial, to the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, DC 20555-0001

Because your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System, accessible at http://www.nrc.gov/reading-rm/adams.html, to the extent possible, it should not include any personal privacy, proprietary, or Safeguards Information so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request withholding of such material, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If Safeguards Information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21, "Protection of Safeguards Information: Performance Requirements."

Dated this the 5th day of October 2010

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NEW REACTORS
DIVISION OF CONSTRUCTION INSPECTION AND OPERATIONAL PROGRAMS
VENDOR INSPECTION REPORT

Docket Nos.:	05200010
Report Nos.:	05200010/2010-201
Vendor:	General Electric Hitachi Nuclear Energy Corporation 3901 Castle Hayne Rd. PO Box 780, Mail Code A65 Wilmington, NC 28401-0780
Vendor Contact:	Mr. Rick Kingston, Vice President ESBWR Licensing, GE Hitachi Nuclear Energy (910) 819-6192 E-mail: rick.kingston@ge.com
Nuclear Industry Activities:	General Electric Hitachi Nuclear Energy Corporation (GEH) has requested to amend the Economic Simplified Boiling Water Reactor (ESBWR) design certification to comply with the U.S. Nuclear Regulatory Commission (NRC) requirements in Title 10 of the *Code of Federal Regulation* (10 CFR), Section 50.150, "Aircraft impact assessment."
Inspection Dates:	July 26-28, 2010, and August 30 to September 1, 2010

Inspectors:		
	Robert Prato, Team Leader,	NRO/DCIP/CQVA
	Francis Talbot,	NRO/DCIP/CQVA
	Mark Caruso,	NRO/DSRA/SPRA
	Dennis Andrukat,	NRO/DSRA/SBPA/SFPT
	Jerry Chuang,	NRO/DE/SEB1
	Michael Magyar,	NRO/DE/CIB1
	Dr. J. Guadalupe Argüello,	Sandia National Laboratories
	Dr. Alexander L. Brown,	Sandia National Laboratories

Approved by:	Richard Rasmussen, Chief Quality and Vendor Branch 2 Division of Construction Inspection & Operational Programs Office of New Reactors

EXECUTIVE SUMMARY

General Electric Hitachi Nuclear Energy Company
Inspection Report Nos.: 05200010/2010-201

The purpose of this U.S. Nuclear Regulatory Commission (NRC) inspection was to verify that General Electric Hitachi Nuclear Energy Company (GEH) had implemented the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.150, "Aircraft impact assessment," and performed a design-specific assessment[1] of the effects on the facility of the impact of a large, commercial aircraft. The inspection was conducted at the GEH facility in Wilmington NC, on July 26-28, 2010, and August 30 to September 1, 2010.

The following served as the bases for the NRC inspection:

- 10 CFR 50.150

The NRC inspection team implemented Inspection Procedure 37804, "Aircraft Impact Assessment," dated April 27, 2010, during the conduct of this inspection.

The NRC had not previously inspected the GEH aircraft impact assessment (AIA). The results of this inspection are summarized below.

With the exception of the violation described below, the NRC inspection team concluded that the portions of the GEH AIA reviewed by the NRC inspection team comply with the applicable requirements of 10 CFR 50.150.

Systems-Loss Assessment

The GEH systems-loss assessment met the requirements of 10 CFR 50.150 and was performed consistent with the guidance provided in Nuclear Energy Institute (NEI) 07-13, "Methodology for Performing Aircraft Impact Assessments for New Plant Designs," issued May 2009.

Fire Damage Assessment

With the exception of the contributing deficiencies to Violation 05200010/2010-201-01, the GEH fire damage assessment met the requirements of 10 CFR 50.150 and was performed consistent with the guidance provided in NEI 07-13. Specifically, with regards to the AIA fire damage assessment deficiencies, the applicant failed to accurately determine fire-damage footprints. In addition, GEH credited fire barrier design features that were not identified and incorporated into its design.

Structural Damage Assessment

With the exception of the contributing deficiencies to Violation 05200010/2010-201-01, the ESBWR structural damage assessment met the requirements of 10 CFR 50.150 and was performed consistent with the guidance provided in NEI 07-13. Specifically, with regards to the

[1] By a ''design-specific'' assessment, the NRC means that the impact assessment must address the specific design of the facility which is either the subject of a construction permit, operating license, standard design certification, standard design approval, combined license, or manufacturing license application (see 74 FR 28129; June 12, 2009).

AIA structural damage assessment deficiency, the applicant failed to adequately consider finite element analyses boundary conditions, initial conditions, and the time duration; to perform mesh refinement sensitivity analyses; to provide a technical justification for the preliminary impact scenarios selected and not selected for the final structural analyses using the NRC specified loading and the material properties given in NEI 07-13, Revision 7; to include in the AIA the bases for not performing an analysis for an aircraft impact on the gantry crane and the corresponding potential effects of the crane dropping on the drywell head; and to consider non-local effects from an aircraft impact.

Documentation and Quality Assessment

The GEH documentation and quality assessment met the requirements of 10 CFR 50.150 and was performed consistent with the guidance provided in Nuclear Energy Institute (NEI) 07-13, “Methodology for Performing Aircraft Impact Assessments for New Plant Designs,” issued May 2009.

REPORT DETAILS

1. Systems-loss Assessment

   a. Inspection Scope

      The NRC inspection team conducted the following systems-loss assessment inspection activities related to the GEH AIA:

      - Verification of the location of key structures, systems, and components (SSCs) that provide core cooling or containment isolation, and spent fuel pool cooling to determine the potential for damage by aircraft impact
      - Verification that key SSCs would be capable of performing their intended function given the established structural, shock, and fire damage footprints and the rule sets and assumptions provided in NEI 07-13
      - Verification that damage from an aircraft impact has resulted in accident initiators such as a breach of the reactor coolant system or the failure of the reactor to trip
      - Verification that success paths for core cooling and spent fuel pool cooling exist

      Specifically, the NRC inspection team reviewed the following GEH AIA documents:

      1. General Electric Hitachi Nuclear Energy Company, "ESBWR Aircraft Impact Assessment Report," GEH NEDE-33512P, Revision 1, dated July 10, 2010 (Safeguards Information (SGI))
      2. General Electric Hitachi Nuclear Energy, "ESBWR Design Control Document", Tier 2, Revision 7, issued March 2010
      3. General Electric Hitachi Nuclear Energy Company, "ESBWR Design Certification Probabilistic Risk Assessment," NEDO 33201, Revision 4, issued September 2009, (ADAMS Accession No. ML092030211).

   b. Observations and Findings

      b.1 Determination of the location of key SSCs

      The NRC inspection team reviewed the applicant's selection of SSCs needed to prevent fuel damage in the core and the documented spatial configuration of those SSCs. SSCs needed to maintain containment intact and to provide for spent fuel pool cooling were not reviewed because the applicant indicated in the DCD that its objective in adding key design features to address the AIA rule was to maintain core cooling and spent fuel pool integrity[2].

      The "ESBWR Aircraft Impact Assessment Report" (Reference 1) identifies the Isolation Condenser System (ICS) described in Section 5 of the "ESBWR Design Control Document" (DCD) (Reference 2), and the Gravity Driven Cooling System (GDCS) described in Section 6 of the DCD as necessary for maintaining core cooling.

[2] The AIA rule requires the applicant to identify and incorporate into the design those design features and functional capabilities to show that, with reduced use of operator actions: (I) The reactor core remains cooled, or the containment remains intact; and (ii) spent fuel cooling or spent fuel pool integrity is maintained. Since the applicant has chosen to maintain core cooling and spent fuel pool integrity to meet the rule, further assessment of containment and spent fuel pool cooling is not necessary.

The NRC inspection team compared the descriptions of SSCs in the assessment report to those in the DCD and the ESBWR probabilistic risk analysis (PRA) (Reference 4) report and confirmed that the scope of SSCs treated in the assessment was complete and consistent with those credited in the PRA core cooling. The inspection team used equipment location data and drawings from the certified fire hazards analysis in Section 9A of the DCD to confirm that the locations of equipment documented in the assessment report were accurate.

The NRC inspection team verified that documentation used by the applicant to develop and identify spatial information (e.g., internal events PRA, internal flooding analysis, internal fire analysis and building layout diagrams) is current.

b.2 Determination of the state of SSCs in the aircraft impact scenarios

The NRC inspection team reviewed those portions of the applicant's assessment report that discussed the approach used for identifying which SSCs will remain capable of performing their intended function following an aircraft impact. The inspection team determined that the ICS includes four independent and redundant condenser loops that are located entirely within the drywell portion of the containment structure. The ICS operates at high pressure and is credited for core cooling following an aircraft impact event that occurs during power operation. Operation of the ICS is initiated automatically by a reactor scram and containment isolation signal which the applicant assumed would occur prior to impact in accordance with the guidance in NEI 07-13. The ICS core cooling success criterion for design basis events, as well as beyond design-basis events addressed in the PRA, is three of four loops. As part of the aircraft impact assessment, the applicant performed an analysis that shows that the core remains covered with water for up to 28 hours following impact with only two of the four IC loops and the associated water pools available. This level of performance satisfies the core cooling acceptance criterion in the AIA rule. The applicant used the MAAP 4.06 code to perform a best-estimate simulation of decay heat removal. The staff approved the use of MAAP 4.06 for best-estimate analysis of beyond design-basis events during its review of DCD, Tier 2, Revision 7, Chapter 19.

The ICS is a high pressure system and will not provide core cooling when the reactor is shutdown and the reactor coolant system is vented. In the AIA, the applicant credits the GDCS for core cooling during this operating state with the normal shutdown cooling system unavailable. This is consistent with the applicant's shutdown PRA that is described in DCD, Tier 2, Revision 7, Chapter 19 (Reference 2), and therefore acceptable.

b.3 Determination of accident conditions

The NRC inspection team reviewed the following conditions to determine if the applicant used the appropriate assumptions and scenarios in determining accident conditions:

- The applicant's success criteria (and the scenario analysis) address initial plant states of 100 percent power and cold shutdown.

- The analysis takes no credit for the availability of offsite power.

- The applicant, as part of its shutdown cooling scenarios, assumes that the non-operating loop of shutdown cooling is out of service for maintenance, the reactor vessel is vented, the water level is at or near the reactor vessel head flange, and the reactor has been shut down for a specified time.

- The applicant has considered the possibility of an anticipated transient without a SCRAM (ATWS).

- The applicant has considered the influence of containment status on the operability of other equipment (e.g., pumps that draw suction water from the containment sump).

- The applicant has searched for instances in which a containment bypass LOCA may occur.

The team reviewed the applicant's treatment of the following potential accident conditions:

- LOCA inside the containment
- LOCA outside the containment
- ATWS
- flooding
- loss of decay heat removal

LOCA inside containment

The NRC inspection team reviewed the applicant's assessment of a LOCA inside the containment to determine if the containment is adequately protected by intervening structures such that it could not be impacted by an aircraft. The NRC inspection team determined that the assessment adequately demonstrated that neither shock damage to the containment nor structural damage inside the containment would occur and, as such, verified that a LOCA inside the containment was not a credible scenario.

LOCA outside containment

The NRC inspection team verified that the applicant considered the potential for LOCA outside containment and its consequences. The team verified that piping connected to the RCS that penetrates containment includes isolation valves that are located inside the primary containment and that the containment is isolated simultaneous with initiation of the ICS.

ATWS

The NRC inspection team reviewed the AIA to determine if the applicant adequately assessed the potential for any damage scenarios that could affect the ability to scram the reactor. The inspection team considered potential structural

damage to the hydraulic control units used for reactor scram. The NRC inspection team reviewed drawings from the fire hazards analysis, confirmed that the hydraulic control units are located below grade, outside all structural damage footprints, and verified that ATWS was not a viable outcome from an aircraft impact.

Flooding

The NRC inspection team reviewed the AIA to determine if the applicant adequately assessed the potential for flooding from a large water source as described in NEI 07-13. The NRC inspection team verified that flooding was not a concern because the design features relied upon for core cooling reside inside the primary containment and can be actuated prior to impact or promptly thereafter.

Loss of Decay Heat Removal

The NRC inspection team reviewed the AIA to determine if the applicant adequately assessed the potential for a loss of decay heat removal event. The team verified that the design features relied upon (i.e., GDCS and ICS) if the normal decay heat removal system is damaged are sufficiently diverse to be relied upon for core cooling.

b.4 Identification of success path

The NRC inspection team reviewed the AIA to determine if the applicant had adequately identified success paths for core cooling. The inspection team reviewed the PRA (NEDO-33201, Revision 4) which serves as the basis for information documented in Chapter 19 of the DCD, and verified that the design features identified by the applicant are shown as success paths for avoiding core damage in the PRA. The staff noted that the success criterion for the ICS in the PRA was more stringent than the success criterion utilized in the AIA. The inspection team verified that the applicant had performed adequate thermal-hydraulic analysis with methods that were the same as those used for the PRA to justify the assertion that core cooling could be maintained for 24 hours when the AIA success criterion is applied.

c. Conclusions

The NRC inspection team found that the portions of the GEH systems-loss assessment reviewed by the NRC inspection team met the requirements of 10 CFR 50.150 and was conducted consistent with the guidance provided in NEI 07-13.

2. Fire Damage Assessment

a. Inspection Scope

The NRC inspection team conducted the following fire damage assessment inspection activities relating to the GEH's AIA:

- Verification that the fire damage assessment identifies and incorporates the necessary design features and functional capabilities

- Verification that the fire damage assessment is realistic and design-specific
- Verification that damage footprints include the effects from the spread of fire damage through existing connected compartments and through new compartment connections due to overpressure
- Verification that the SSCs determined to be damaged are no longer credited.

Specifically, the NRC inspection team reviewed the following GEH AIA documents:

1. General Electric Hitachi Nuclear Energy Company, "ESBWR Aircraft Impact Assessment Report," GEH NEDE-33512P, Revision 1, dated July 10, 2010 (Safeguards Information (SGI))
2. General Electric Hitachi Nuclear Energy, "ESBWR Design Control Document", Tier 2, Revision 7, issued March 2010

b. Observations and Findings

b.1 Fire-damage assessment

The GEH "ESBWR Aircraft Impact Assessment Report" (Reference 1) evaluates a total of eight impact scenarios for the reactor building and one impact scenario for the control building. The NRC inspection team reviewed all nine impact scenarios to determine if the ESBWR AIA fire-damage assessment was performed consistent with the requirements of the rules and the guidance provided in NEI 07-13. In general, the NRC inspection team verified that the fire damage footprints were developed consistent with the rule, the guidance, and the assumptions in NEI 07-13 with one exception.

In multiple reactor building scenarios, the NRC inspection team determined that GEH did not apply a realistic analysis for the fire and overpressure spread across interfacing walls between the physical damage zones and the respective vertical HELB chases (i.e. the walls separating physical damage footprints from fire damage footprints). In these situations, the applicant did not follow the NEI 07-13 fire spread rule sets. Instead, the applicant states that these HELB chases only receive fire damage as opposed to fire plus overpressure. The AIA stated that the deflagration-induced overpressure will decrease (an unspecified amount) due to the increase in velocity that would occur when entering the HVAC ductwork from the area physically affected by the aircraft impact. As this overpressure continues into the ductwork, located within the HELB chase, the applicant assumed that the ductwork will fail within the first couple of feet causing de-pressurized fire spread to enter the HELB chase. Upon entering and filling the HELB chase volume, the pressure will further dissipate down to ambient. Therefore, the applicant concluded that the 3-hour fire rated HELB chase would confine the fire damage. This discussion was not supported by any basis for asserting that the HELB chases only receive fire damage and not overpressure damage in addition to fire damage, and is not consistent with the guidance in NEI 07-13.

The NRC inspection team determined GEH's approach to be unrealistic. Specifically, the inspection team determined that it was unrealistic to assume that the HVAC duct seal in the interfacing wall will remain intact such that the overpressure only travels into the ductwork itself. It was also unrealistic for GEH to assume that the resulting overpressure from an aircraft impacting just outside

the HELB chase would dissipate in matter of feet inside HVAC ductwork. In addition, it was unrealistic of GEH to consider that other penetration seals for pipes and cabling along the interfacing walls will also remain intact. Any failed seals would realistically provide a pathway for an overpressure to enter into the HELB chase.

Consistent with NEI 07-13 guidance, the NRC inspection team determined that the applicant should have assumed the loss of all penetration seals along the interfacing walls from the impact and overpressure damage. Further, the applicant should have assumed that the breach from the loss of seal integrity would provide for a direct pathway for the aircraft impact fireball to pass into the HELB chase. A fireball caused from an aircraft impact would consist of fire and pressure that would require a 5-psid rated HELB chase, including all penetration seals, to confine the fire damage within the HELB chase. Otherwise, the overpressure would damage the integrity of the penetrations at other elevations and allow fire to propagate beyond those areas currently identified in the applicant's fire damage footprint drawings.

The NRC inspection team verified that both the ESBWR DCD and the AIA did not include any specific calculations or design details (e.g., the ductwork layout, the size of the duct "orifice" opening, the pressure rating of the ductwork, the HELB chase design details/specifications, or HELB analysis) to justify the assumptions or judgments applied by the applicant. In addition, the ESBWR DCD key design features do not include the HELB chase and its penetration seals as 5 psid rated barriers or any HVAC design relied upon in the GEH assessment.

The NRC inspection team verified that the applicant did not provide a realistic analysis to justify that the deflagration-induced overpressure does not spread beyond the applicable HELB chase. The consequence from not adequately evaluating overpressure fire spread across the HELB chase barrier has been determined to have the potential to increase the fire damage footprints from two divisions to three divisions and, in one scenario, potentially affect portions of all four safety divisions being damaged by fire. This failure to adequately evaluate the spread of fire that could lead to undersized fire damage footprints is one example of a deficiency in the assessment contributing to Violation 05200010/2010-201-01 that cites GEH for not performing an adequate assessment using a realistic analysis as required by 10 CFR 50.150(a)(1).

The NRC inspection team reviewed the control building aircraft impact scenario. The applicant's report affirms that a total loss of the control building would not prevent a reactor SCRAM, any MSIV closure, or adversely affect the operation of ICS. The applicant's assessment concludes that the ESBWR design maintains its ability to cool the core for the time duration required for the aircraft impact rule. The inspection team reviewed and agreed with the applicant's conclusion regarding total loss of the control building and the remaining ability to maintain core cooling.

The NRC inspection team also reviewed the fire areas and fire barriers within the fire damage footprints used in the AIA and determined that the resulting design features and functional capabilities identified and credited in the AIA are not consistent with the design features and functional capabilities as documented in the current design as submitted in the ESBWR DCD. For example, the four divisional electrical chases in the reactor building are credited as a 5psid and 3-hour fire-rated barriers in the AIA to prevent fire damage spread into the vertical chase and the subsequent spread of fire between elevations. The DCD does not identify these divisional electrical chases, specifically the chase barriers, as key design features or as being 5psid and 3-hour fire-rated barriers.

In addition, the ESBWR DCD credits fire barriers for maintaining separation and preventing the spread of fire between the reactor building East side divisions from the West side divisions. However, the AIA contained several reactor building scenarios that resulted in a breach in the East-West separation contrary to the DCD.

The different fire barrier details and the resulting differences in the design features and functional capabilities between the DCD and AIA is another example of a deficiency in the assessment contributing to Violation 05200010/2010-201-01 that cites GEH for the failure to identify all the design features and functional capabilities necessary to meet the Aircraft Impact Assessment rule requirements of 10 CFR 50.150(a)(1).

b.2 Fire Damage Effects on SSCs

The NRC inspection team reviewed a sample of fire damage footprints to determine if the applicant had properly identified the SSCs within the fire damage footprints. The NRC inspection team verified that the applicant did identify all the SSCs within the fire damage footprint and that the applicant had correctly considered the identified SSCs as failing within 5 minutes from the start of the fire consistent with the guidance provided in NEI 07-13. Further review of damage to the SSCs was conducted and documented as part of the systems-loss assessment.

c. Conclusions

The NRC inspection team found that, with the exception of the contributing deficiencies to Violation 05200010/2010-201-01, the portions of the ESBWR fire-damage assessment reviewed by the NRC inspection team met the requirements of 10 CFR 50.150 and was conducted consistent with the guidance provided in NEI 07-13.

3. Structural Damage Assessment

a. Inspection Scope

The NRC inspection team conducted the following structural damage assessment inspection activities related to the ESBWR AIA:

- Verification of information found in plant documentation including plant arrangement drawings that display the locations of major equipment, plant elevation drawings that document the relative heights of various buildings, civil-structural drawings that provide wall thicknesses and reinforcement details, and material specifications
- Verification of general structural analysis considerations such as design inputs, analysis parameters and assumptions, computer codes, methods used for structural analyses and results to determine whether the applicant has adequately analyzed the effects of and damage to structures resulting from global loading arising from an aircraft impact
- Verification of the containment and spent fuel pool impact analyses to determine whether the applicant has met the sufficiency criteria in NEI 07-13, Section 2.5
- Verification of the structural damage footprint assessments to determine whether the applicant has adequately assessed the containment and other reinforced concrete buildings that contain essential SSCs for maintaining reactor core and spent fuel pool cooling using the damage rule sets in NEI 07-13

Specifically, the NRC inspection team reviewed the following ESBWR AIA documents:

1. James, R. J. and L. Zhang, "Evaluation of Aircraft Impact on ESBWR Plant Design – Structural Response Analyses," Report ANA-QA-0207, ANATECH Corporation, San Diego, CA, issued June 2009 (SGI).
2. General Electric Hitachi Nuclear Energy Company, "ESBWR Aircraft Impact Assessment Report," GEH NEDE-33512P, Revision 1, dated July 10, 2010 (Safeguards Information (SGI))
3. General Electric Hitachi Nuclear Energy Company, "ESBWR Aircraft Impact Assessment Report," GEH NEDE-33512P, Revision 2, issued August 10, 2010 (Safeguards Information (SGI))
4. General Electric Hitachi Nuclear Energy, "ESBWR Design Control Document", Tier 2, Revision 7, issued March 2010
5. "ANATECH Corporation, ANACAP-U/ANAMAT Theory Manual Version 2.5," Revision 0 (DRAFT), ANA-QA-145, ANATECH, San Diego, CA, issued April 1998.
6. "ANATECH Corporation, ANACAP-U ANATECH Concrete Analysis Package Version 2.5, Verification and Validation Manual," ANA-QA-144, Revision 1 draft, ANATECH, San Diego, CA, issued September 1998.
7. "ANATECH Corporation, ANACAP-U User's Manual Version 2.5," ANA-97-0221, Revision 4, ANATECH, San Diego, CA, issued September 1997.
8. "ANATECH Corporation, ESBWR Structural Design Support, Supplemental Material Compiled for NRC AIA Inspection," ANATECH, San Diego, CA, dated July 26-30, 2010.
9. "ANATECH Corporation, Individual Project Plan, Structural Analysis Services In Support of ESBWR Design and Licensing," ANA-QA-194, ANATECH, San Diego, CA, issued March 2009.
10. Record of Analysis, records for verification, and documentation of analyses performed (various dates).
11. James, R. J., Rashid, Y.R., and L. Zhang, "Aircraft Crash Impact at Nuclear Power Plants, Validation of Analysis Methodology," ANA-03-0637, ANATECH Corp., San Diego, CA, issued December 2003.

12. "ANATECH Corporation, MEMO to Bob Kennedy, Structural Mechanics Associates and Bob Nickell, Applied Science and Technology from Randy James, ANATECH, "Test for Shear Failure in Beam," provided via email on January 31, 2003.
13. Sandia National Laboratory, "Water Slug Test Problems, Software Test Results for ABAQUS/Explicit/ANACAP-U for SNL WS Tests" no date provided
14. QA Software Verification, Software Verification documentation extracted from QA Records various dates
15. Copy of Design Input Control, 8/30/2010.

b. Observations and Findings

b.1 Structural Assessment Document Review

The NRC inspection team reviewed the applicant's plant structural assessment design inputs including plant arrangement drawings, plant elevation drawings, civil-structural drawings, and material specifications. The inspection team verified that the plant arrangement drawings display the locations of major equipment, the plant elevation drawings identified the relative heights of various buildings, and the civil-structural drawings provided wall thicknesses and reinforcement details accurately and consistent with the ESBWR DCD.

b.2 General Structural Analysis

- The NRC inspection team reviewed the AIA structural damage assessment including design inputs, analysis parameters and assumptions, computer codes, method used for structural analyses and results. Specifically, the NRC inspection team reviewed the ABAQUS computer code used in the structural analysis for AIA and verified that the applicant had validated and verified the code for the applications assessed and had adequately documented the validation and verification. It should be noted that the applicants' preliminary analyses were performed using ABAQUS 5.8 while the final analyses were performed using ABAQUS 6.8.1 due to the continuous evolutionary-nature of software (as well as hardware) and the time laps between the preliminary and final assessments. In this particular instance, the applicant encountered some difficulties in applying the two different versions of the software, which were eventually overcome.

  The NRC inspection team reviewed the design inputs for ABAQUS including the structural analysis assumptions and limitations, the type of finite elements used in each analysis, material models considered, sensitivity to model mesh refinement, and the time duration of the analysis. The inspection team verified that the applicant had adequately demonstrated and justified the structural design input for a sampling of analysis.

- The NRC inspection team reviewed each of the finite element analyses performed by the applicant. The assessment did not adequately consider

finite element analyses boundary conditions, initial conditions, and the time duration in the analyses, as well as the physical extent of each model. However, during the course of inspection activities, the applicant presented and discussed a sampling of inputs and results which included discussions relating to the boundary conditions, initial conditions, and the criteria used to determine them. Although these conditions appeared to be appropriately considered by the applicant, they were not analyzed in the AIA, and rendered that AIA inadequate.

The NRC inspection team reviewed the structural analyses and was unable to find any mesh refinement sensitivity analysis in its review of the mesh designs used in the structural analyses. The applicant informed the inspection team that sensitivity analyses were not performed for the ESBWR AIA. The applicant further explained that the meshing design used in the analysis was based on past experience and judgment of the analyst for the applicable class of problems. The NRC inspection team determined that the judgment to not perform a sensitivity analysis was not acceptable for the mesh designs used in the ESBWR structural analyses because the analyst did not provide adequate justification. Therefore, the inspection team determined that mesh refinement sensitivity analyses, consistent with the guidance provided in NEI 07-13, should have been performed.

The applicant's failure to adequately consider finite element analyses boundary conditions, initial conditions, the time duration in the analyses, and the physical extent of each model; and failure to perform mesh refinement sensitivity analyses are examples of deficiencies in the assessment contributing to Violation 05200010/2010-201-01 that cites GEH for not performing an adequate assessment using realistic analyses as required by 10 CFR 50.150(a)(1).

- The NRC inspection team reviewed the structural damage impact scenarios to determine if the applicant considered the appropriate scenarios in its assessment. The AIA includes preliminary analyses of nine structural damage impact scenarios, one of which (impact scenario 9) was an extension of preliminary impact scenario 1 to assess the effects of debris falling on the containment drywell head. The applicant indicated that the preliminary analyses were performed prior to the availability of the NRC specified loads and the guidance provided in NEI 07-13, and they were included in their AIA report because they were used to help determine the impact scenarios used in their "final" analyses to meet the requirements of 10 CFR 50.150. Of the nine preliminary analyses, only four structural damage impact scenarios were included in the "final analyses" and reanalyzed using the NRC specified aircraft impact loading and material properties given in NEI 07-13, Revision 7. The applicant did not reanalyze the remaining (5) preliminary structural damage impact scenarios using the NRC specified aircraft impact loading and the material properties used in these five analyses were somewhat different (depending on the material) from those given in NEI 07-13, Revision 7.

The NRC inspection team reviewed the rationale used to determine which preliminary structural damage impact scenarios would be reanalyzed for inclusion in the applicant's AIA. The AIA did not contain a technical justification for the four preliminary structural damage impact scenarios that were included in the applicant's AIA. The NRC inspection team also reviewed the rationale used to exclude the five preliminary structural damage impact scenarios from the applicant's final AIA. The applicant explained that they did not reanalyze the remaining five structural damage impact scenarios for the NRC specified loading because they determined that the higher peak load in the NRC specified loading would not be enough to cause sufficiently more damage in the structures affected that could lead to additional failures. Considering the highly nonlinear nature of a structural response to the differences in the EPRI and NRC impact characteristics and material properties, the NRC inspection team determined that the added damage from applying a higher peak load on different material properties cannot be predicted. Therefore, the NRC inspection team determined that the applicant did not provide adequate technical justification for not reanalyzing all nine preliminary structural damage impact scenarios for the NRC specified loading in its final AIA.

In addition, the NRC inspection team reviewed the final four structural damage impact scenarios to determine if the applicant had adequately conducted the assessments. The inspection team verified that the material models for the four cases in the final analyses were adequately documented and consistent with NEI 07-13, Rev. 7 guidance.

The applicant's failure to provide a technical justification for selecting the four final impact scenarios selected for re-analyses using the NRC specified impact loading and to provide an adequate technical justification for the adequacy of the AIA with the five preliminary structural damage impact scenarios eliminated from the analyses using the NRC specified loading are examples of deficiencies in the assessment contributing to Violation 05200010/2010-201-01 that cites GEH for not performing an adequate assessment using realistic analyses as required by 10 CFR 50.150(a)(1).

- The NRC inspection team reviewed the final structural damage impact scenarios to determine if the applicant had adequately conducted the assessments. The inspection team determined that the AIA did not consider the potential for an aircraft impact on the gantry crane. In one final analysis, the applicant analyzed the load effects from the entire mass of the EPRI plane on the drywell head. The applicant identified the mass of the plane debris as significantly higher than the mass of the gantry crane, which would make the EPRI loading analysis more conservative and would bound the potential effects from the gantry crane falling on the drywell head. However, the assessment did not include the applicant's basis for not performing an analysis for an aircraft impact on the gantry crane and the corresponding potential effects of the crane dropping on the drywell head.

The applicant's failure to include in the AIA the basis for not performing an analysis for an aircraft impact on the gantry crane and the corresponding potential effects of the crane dropping on the drywell head is another example of a deficiency in the assessment contributing to Violation 05200010/2010-201-01 that cites GEH for not performing an adequate assessment using realistic analyses as required by 10 CFR 50.150(a)(1).

- The NRC inspection team reviewed a sample of final structural damage impact scenario analyses to determine if the applicant properly applied the NRC-supplied forcing function in its AIA. The inspection team verified that the applicant properly applied the NRC-supplied forcing function in its final structural damage impact scenarios analyses.

- The NRC inspection team reviewed a sample of structural damage analyses. The inspection team identified that the applicant had not adequately analyzed and included in the AIA the responses to, and damage of, structures resulting from non-local (e.g., fracture of structural components at critical sections, overturning and sliding of the building) effects arising from an aircraft impact such as those that occurred far away from the striking zone. The NRC inspection team determined that the applicant did not adequately consider the responses to, and damage of, structures resulting from non-local effects.

  The failure to effectively consider the responses to, and damage of, structures resulting from non-local effects arising from an aircraft impact is another example of a deficiency in the assessment that contributed to Violation 05200010/2010-201-01 that cites GEH for not performing an adequate assessment using realistic analyses as required by 10 CFR 50.150(a)(1).

b.3 Containment structure and spent fuel pool specific impact assessment

The NRC inspection team reviewed the containment and spent fuel pool impact analyses to determine whether the applicant has met the sufficiency criteria in NEI 07-13, Section 2.5. The NRC inspection team reviewed the structural damage assessment as it relates to local loading on the containment structure and verified that the following activities were conducted in the analyses reviewed by the inspection team:

- The applicant adequately documented and cross-checked the aircraft engine parameters used in the analysis against NRC-specified parameters.

- The applicant properly applied the various local loading formulas referenced in NEI 07-13, Subsection 2.1.2, to arrive at the degree of local damage.

- The applicant used the formulas cited in NEI 07-13 and approved by the NRC.

The NRC inspection team reviewed the structural damage assessment as it relates to gross loading of the containment structure. The inspection team verified that the following activities were conducted in the analyses:

- The applicant effectively used and adequately documented the application of the force time-history analysis method and cross-checked it for its equivalency to the NRC-specified force time-history.

- The applicant had adequately documented the application of the missile-target interaction analysis method and cross-checked it for its equivalency to the NRC-specified force time-history.

- The missile-target interaction analysis method reasonably captured the mass distribution of the missile when a “reverse-engineering” approach was used to determine the missile-target interaction from the force-time history.

- For the application of the force time-history analysis method, the applicant properly used and adequately documented the NRC-specified spatial distribution of the impact force in the analyses.

The NRC inspection team reviewed a sample of documents for material characterization and failure criteria related to the structural damage assessment and verified that the following analysis activities were conducted:

- The material properties and the equations used to model the nonlinear behavior of both steel and reinforced concrete materials used in the analyses are consistent with the material properties and equations documented in NEI 07-13, Section 2.3, and are adequately documented.

- The applicant properly applied the dynamic increase factors specified in NEI 07-13, Subsection 2.3.1, for the various materials use in the analyses.

- The applicant properly applied the ductile failure strain limits specified in NEI 07-13, Subsection 2.3.2, for the various materials used in the analyses.

- The concrete structural failure criteria used in the analyses are appropriate and consistent with the criteria specified in NEI 07-13, Subsection 2.3.3, and are adequately documented.

- The applicant properly applied the material models specified in NEI 07-13, Subsection 2.3.4.

- The applicant properly applied and adequately documented the structural integrity failure criteria specified in NEI 07-13, Subsection 2.3.5.

The NRC inspection team reviewed NEI 07-13, Section 2.4, regarding the major assumptions applied to the containment structural analyses and verified that the

following activities were conducted in the analyses reviewed by the inspection team:

- The missile-target interaction analysis model properly assumed that the aircraft impact was perpendicular to the centerline of the containment.

- The missile-target interaction analysis model properly assumed takeoff weight such that the missile-target interaction model is equivalent to the NRC-specified force time-history.

- Containment regions containing critical penetrations received an appropriate level of special consideration.

- Spent fuel pool analyses properly assumed that both the engine and the aircraft fuselage strike was perpendicular to and at the mid-point of the spent fuel pool wall.

- The applicant assessed potential aircraft impact at other locations that could result in greater consequences.

- The applicant did not take credit for fuel pool water inventory in its spent fuel pool analyses.

The NRC inspection team reviewed NEI 07-13, Section 2.5, regarding the sufficiency criteria applied to the containment structural analyses and verified that the following activities were conducted in the analyses reviewed by the inspection team:

- The spent fuel pool was concluded to remain intact, consistent with the sufficiency criteria of NEI 07-13, Section 2.5.2.

b.4 Structural damage footprint assessment

The NRC inspection team reviewed the structural damage footprint analyses to determine that the following items of interest related to the damage rule sets identified in NEI 07-13, Chapter 3, “Heat Removal Capability,” have been met. The NRC inspection team reviewed the structural damage rule sets and verified that the following activities were conducted in the analyses reviewed by the inspection team:

- Structures of concern that contain systems, structures, and components (SSCs) have been identified.

- A systematic evaluation of susceptible damage was conducted and adequately documented.

- Assumptions used to determine elevations of concern have been addressed and adequately documented.

- Each external face of each building exposed to a direct hit has been divided into two categories, containment structures and other reinforced concrete buildings; and has been analyzed and adequately documented.

Structural damage rule sets for containment structures were appropriately assessed.

The NRC inspection team reviewed the structural damage rule sets for reinforced concrete buildings for consistency with the guidance in NEI 07-13, Subsection 3.3.2 and Figure 3-10, and verified that the following activities were conducted in the analyses reviewed by the inspection team:

- Various impact points have been investigated consistent with the guidance in NEI 07-13 in order to define the damage footprint, and has been adequately documented.

- Structural damage rule sets regarding perforations were developed consistent with the guidance in NEI 07-13, Table 3-2 or Subsection 3.3.2.

- Shock damage was evaluated in the structural damage footprints and these evaluations have been adequately documented.

- The guidance in NEI 07-13, Table 3-3, was used to define the shock damage footprints and was adequately documented.

- Shock effects impacting seismic separation between buildings has been adequately assessed and documented.

c. Conclusions

The NRC inspection team found that, with the exception of the contributing deficiencies to Violation 05200010/2010-201-01, the portions of the ESBWR structural damage assessment reviewed by the NRC inspection team met the requirements of 10 CFR 50.150 and was conducted consistent with the guidance provided in NEI 07-13.

4. AIA Documentation and Quality Assessment

a. Inspection Scope

The NRC inspection team reviewed the GEH AIA documentation and quality plan as developed and implemented by the applicant and its contractor, ANATECH Corporation, in the development of the AIA, to verify compliance with the requirements of 10 CFR 50.150. Specifically, the NRC inspection team reviewed the following documents and the implementation of the quality plan in the development of the ESBWR AIA:

1. General Electric Hitachi Nuclear Energy Company, “ESBWR Aircraft Impact Assessment Report,” GEH NEDE-33512P, Revision 1, dated July 10, 2010 (Safeguards Information (SGI))
2. General Electric Hitachi Nuclear Energy, “ESBWR Design Control Document”, Tier 1, Revision 7, issued March 2010

3. General Electric Hitachi Nuclear Energy, “ESBWR Design Control Document”, Tier 2, Revision 7, issued March 2010
4. General Electric Hitachi Nuclear Energy Company, “NP-2010 COL Demonstration Project Quality Assurance Plan,” NEDO-33181, Revision 6, issued August 2009
5. General Electric Hitachi Nuclear Energy Company, “Design Record Files,” Common Procedure (CP)-03-08, Revision 1, dated June 27, 2009
6. General Electric Hitachi Nuclear Energy Company, “Independent Design Verification,” CP-03-09, Revision 4, dated December 17, 2009
7. General Electric Hitachi Nuclear Energy Company, “Evaluation of Design Changes Affecting NRC Licensing Documents,” CP-03-220, Revision 0, dated July 23, 2010
8. General Electric Hitachi Nuclear Energy Company, “Protection of Safeguards information,” Engineering Operating Procedure (EOP) 60-7.00, Revision 5, dated October 9, 2009
9. General Electric Hitachi Nuclear Energy Company, “Aircraft Impact Safe Shutdown Assessment (SSA),” Notebook, (Non Safeguard Related Analysis)
10. General Electric Hitachi Nuclear Energy Company, “Aircraft Impact Safe Shutdown Assessment(SSD), Notebook, Revision 1, (Non Safeguard Related Analysis
11. General Electric Hitachi Nuclear Energy Company, “Calculation file for ICS Success Criteria,” 0000-100-5515
12. General Electric Hitachi Nuclear Energy Company, Calculation file for ESBWR Safe Shutdown Analysis, 0000-106-4220
13. General Electric Hitachi Nuclear Energy Company, “Structural and Fire Damage Footprint Figures,” Revision 1, Appendix A, issued July 2009
14. “ANATECH Corporation, ANACAP-U/ANAMAT Theory Manual Version 2.5,” Revision 0 (DRAFT), ANA-QA-145, ANATECH, San Diego, CA, issued April 1998
15. “ANATECH Corporation, ANACAP-U ANATECH Concrete Analysis Package Version 2.5, Verification and Validation Manual,” ANA-QA-144, Revision 1 draft, ANATECH, San Diego, CA, issued September 1998
16. “ANATECH Corporation, Evaluation of Aircraft Impact ESBWR Plant Design – Structural Response Analyses,” ANA-QA-0207, Revision 0, issued July 2009
17. “ANATECH Corporation, Individual Project Plan, Structural Analysis Services In Support of ESBWR Design and Licensing,” ANA-QA-194, ANATECH, San Diego, CA, issued March 2009
18. “ANATECH Corporation, MEMO to Bob Kennedy, Structural Mechanics Associates and Bob Nickell, Applied Science and Technology from Randy James, ANATECH, “Test for Shear Failure in Beam,” provided via email on January 31, 2003
19. Record of Analysis, records for verification, and documentation of analyses performed (various dates)
20. James, R. J., Rashid, Y.R., and L. Zhang, “Aircraft Crash Impact at Nuclear Power Plants, Validation of Analysis Methodology,” ANA-03-0637, ANATECH Corp., San Diego, CA, issued December 2003
21. General Electric Hitachi Nuclear Energy Company, “Design Record Files,” Common Procedure (CP)-03-08, Revision 1, dated June 27, 2009,
22. General Electric Hitachi Nuclear Energy Company, “Independent Design Verification,” CP-03-09, Revision 4, dated December 17, 2009

23. General Electric Hitachi Nuclear Energy Company, "Evaluation of Design Changes Affecting NRC Licensing Documents," CP-03-220, Revision 0, dated July 23, 2010
24. General Electric Hitachi Nuclear Energy Company, "Protection of Safeguards information," Engineering Operating Procedure (EOP) 60-7.00, Revision 5, dated October 9, 2009
25. General Electric Hitachi Nuclear Energy Company, Calculation file for ICS Success Criteria, 0000-100-5515
26. General Electric Hitachi Nuclear Energy Company, Calculation file for ESBWR Safe Shutdown Analysis, 0000-106-4220
27. General Electric Hitachi Nuclear Energy Company, Structural and Fire Damage Footprint Figures, Revision 1, Appendix A, issued July 2009
28. Letter from Ken Canavan, (Electric Power Research Institute Senior Manager) to Mr. David A Christian, (Chair of the NEI Aircraft Impact Assessment Group), "GE-Hitachi Nuclear Energy ESBWR Aircraft Impact Assessment Review," dated July 29, 2010
29. General Electric Hitachi Nuclear Energy Company, Standard Purchase Order 437026040, to ANATECH, effective date December 1, 2008
30. General Electric Hitachi Nuclear Energy Company, ET -000573, Revision 3, Attachment T, Technical, Quality and Administrative Requirements, PO Description, Engineering Services ESBWR Structural Design Support, Statement of Work, Task Title, Aircraft Impact Assessment, dated October 2008

b. Observations and Findings

b.1 Documentation

Section 5.1, "Documentation," of NEI 07-13 contains the industry guidance for documenting the AIA. With regards to documentation, NEI 07-13 states, in part, that each vendor should retain a file of the complete set of analyses performed in a manner consistent with the level of detail described in this methodology document. The documentation should be sufficiently complete and thorough to support an onsite review by the NRC to determine the overall adequacy of the assessment conducted.

During its review of the AIA documentation, the NRC inspection team determined that some of the information documented within the ESBWR AIA was incomplete and, in some cases, inconsistent with the information in the ESBWR DCD. The NRC inspection team identified that the AIA credited fire barrier design features that were not identified in the design.

In addition, the AIA failed to provide an adequate justification for fire damage and structural damage assessment assumptions that limited the NRC inspection team's ability to effectively assess applicable portions of the AIA. The specific findings relating to the adequacy of the AIA to use realistic analyses as required by 10 CFR 50.150(a)(1) are discussed throughout the inspection report details.

b.2 Quality Requirements

Section 5 of NEI 07-13 states that the quality assurance standards and measures applied by an applicant must be able to establish the validity of the assessment and supporting calculations, and that the results must be documented consistent with 10 CFR 50.150.

GEH NEDO-33181, "NP-2010 COL Demonstration Project Quality Assurance Plan," for the ESBWR Project QA Plan (PQP) identifies and defines quality elements intended to meet the standards and measures identified in NEI 07-13. This includes the following three quality elements: (1) identification of inputs; (2) the performance, and verification and validation (V&V) of the assessment; and (3) documentation. The inspection team also reviewed the ANATECH quality plan and QA reports and verified that the quality plan requires verification of the inputs, assumptions, methodology, assessment results, and conclusions. The NRC inspection team verified that, for those portions of the ESBWR AIA reviewed by the inspection team and with the exception of those items identified in this report, the inputs, assumptions, methodology, assessment results, and conclusions were applied consistent with the ESBWR PQP.

c. Conclusions

The NRC inspection team found that the portions of the ESBWR documentation and quality requirements reviewed by the NRC inspection team, with the exception of the examples provided that indicate deficiencies associated with demonstrating sufficient realism, met the requirements of 10 CFR 50.150 and was conducted consistent with the guidance provided in NEI 07-13.

5. Entrance and Exit Meetings

On July 26, 2010, the NRC inspection team discussed the scope of the inspection with Mr. Gary Miller, from GEH, and with a representatives from ANATECH. On September 1, 2010, the NRC inspection team presented the inspection results and observations during an exit meeting with Mr. Jerald Head, from GEH, and with the representative from ANATECH. In addition, on October 4, 2010, the NRC inspection team contacted GEH to provide clarification on a potential finding and performed a final exit of the GEH AIA inspection. Attachment 2 to this report lists the entrance and exit meeting attendees.

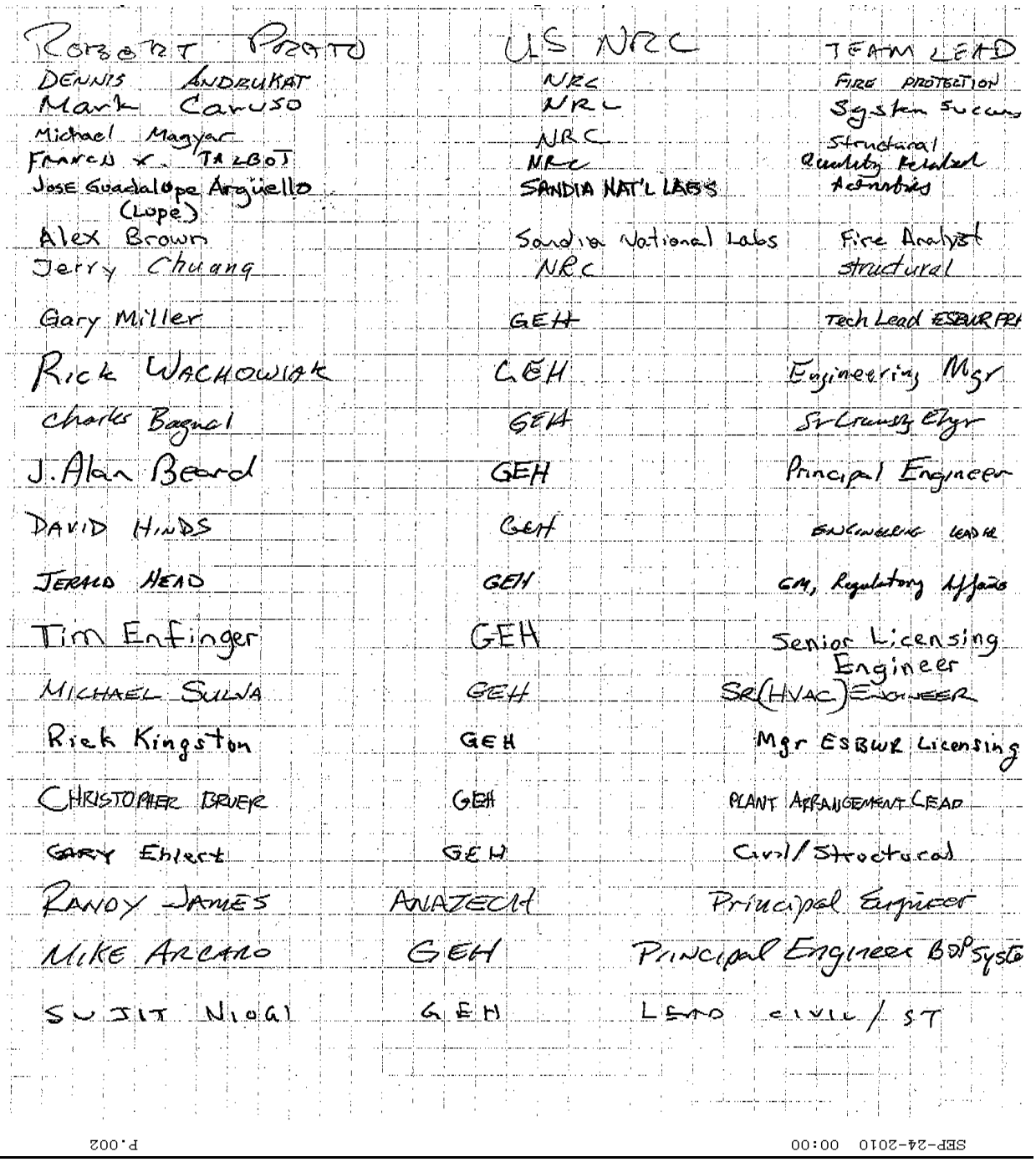
ATTACHMENT 1

1. PERSONS CONTACTED

Name	Company/Employer	Area
Miller, Gary	GEH	PRA
Bagbal, Charles	GEH	Licensing
Beard, J. Alan	GEH	New Plant Engineering
Niogi, Sujit	GEH	Civil Engineering
Ehlert, Gary	GEH	Civil Engineering
Quitana, Louis	GEH	Program Manager
Sulva, Michael	GEH	HVAC
James, Randy	ANATECH	Structural Analysis Lead
Bruer, Christopher	GEH	Senior Licensing Engineer
Hinds, David	GEH	Engineering

ATTACHMENT 2

1. ENTRANCE MEETING ATTENDEES



Robert Pascarelli	US NRC	TEAM LEAD
Dennis Andrukat	NRC	Fire Protection
Mark Caruso	NRC	System Success
Michael Magyar	NRC	Structural
Frances K. Talbot	NRC	Quality Related Activities
Jose Guadalupe Arguello (Lupe)	Sandia Nat'l Labs	
Alex Brown	Sandia National Labs	Fire Analyst
Jerry Chuang	NRC	Structural
Gary Miller	GEH	Tech Lead ESBWR PRA
Rick Wachowiak	GEH	Engineering Mgr
Charles Bagnal	GEH	Sr Licensing Engr
J. Alan Beard	GEH	Principal Engineer
David Hinds	GEH	Engineering Leader
Jerald Head	GEH	CM, Regulatory Affairs
Tim Enfinger	GEH	Senior Licensing Engineer
Michael Sulva	GEH	SR(HVAC) Engineer
Rick Kingston	GEH	Mgr ESBWR Licensing
Christopher Brueer	GEH	Plant Arrangement Lead
Gary Ehlert	GEH	Civil/Structural
Randy James	Anatech	Principal Engineer
Mike Arcano	GEH	Principal Engineer BOP Syste
Sujit Nigal	GEH	Lead civil/ST

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2 September 01, 2010, EXIT MEETING ATTENDEES

Robert Pratt	US NRC	TEAM LEAD
Dennis Andrukat	NRC	Fire Protection
Mark Caruso	NRC	System Success
Michael Magyar	NRC	Structural
Francis X. Talbot	NRC	Quality Related Activities
Jose Guadalupe Arguello (Lupe)	Sandia Nat'l Labs	
Alex Brown	Sandia National Labs	Fire Analyst
Jerry Chuang	NRC	Structural
Gary Miller	GEH	Tech Lead ESBWR PRA
Rick Wachowiak	GEH	Engineering Mgr
Charles Bagnal	GEH	Sr Licensing Engr
J. Alan Beard	GEH	Principal Engineer
David Hinds	GEH	Engineering Leader
Jerald Head	GEH	CM, Regulatory Affairs
Tim Enfinger	GEH	Senior Licensing Engineer
Michael Sulva	GEH	SR(HVAC) Engineer
Rick Kingston	GEH	Mgr ESBWR Licensing
Christopher Brover	GEH	Plant Arrangement Lead
Gary Ehlert	GEH	Civil/Structural
Randy James	ANATECH	Principal Engineer
Mike Arcano	GEH	Principal Engineer BOP Syste
Sujit Nigal	GEH	Lead civil/ST

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3. October 04, 2010, EXIT MEETING ATTENDEES

Name	Organization	Title
Charles Bagnal	GEH	Senior licensing engineer
Alan Beard	GEH	Principle engineer
Randy James	ANATEC Corporation	Consultant
Rick Kingston	GEH	Manager, ESBWR licensing
Jon McLamb	GEH	Project Manager, GEH
Gary Miller	GEH	Technical lead, ESBWR PRA
Amy Cubbage	NRC	Project Manager, ESBWR
David Misenhimer	NRC	Project engineer
Brian Thomas	NRC	Chief, Structural Branch, DE
Mark Caruso	NRC	Senior Risk/Reliability Analyst
Rick Rasmussen	NRC	Chief, Quality and Vendor Inspection Branch, DCIP
Laura Dudes	NRC	Deputy Office Director, DE
Robert Prato	NRC	Team Leader

2. Inspection Procedures Used

Inspection Procedure 37804, “Aircraft Impact Assessment”

3. List Of Items Opened, Closed, And Discussed

The NRC has not performed any previous inspections of the GEH AIA.

The NRC found the following items during this inspection:

Item Number	Status	Type	Description
05200010/2010-201-01	Open	NOV	10 CFR 50.150(a)(1)